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The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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THE FLORA OF THE SHADES STATE PARK, INDIANA, AND THE GEOGRAPHICAL DISTRIBUTION OF THE SPECIES

By JACK MCCORMICK

The great number of deeds issued in west-central Indiana within a few years of the completion of the original land survey of 1820 justifies the supposition that the fertile till-soils of the region were an alluring indemnification for the hardships necessarily borne by the first colonists. The fertility of the land, however, was concomitantly to result in the decimation of the forest-covered acres of that portion of the State within half a century. Record (40) in a resume of forest conditions in Montgomery County, Indiana, related that, "Trees and saplings were cut and their trunks were made into corduroy roads. Regular logging bees were held and tree after tree was cut, rolled together, and burned. The best (trees) were cut into rails or hewn into sills, or used for firewood."

The dissected land bordering Sugar Creek and its tributaries, however, provided little enticement to the farmer; and thus their forests escaped the ruthless destruction that befell those of the surrounding uplands. One such area, which was spared denudation, became known as the "Shades of Death." Its name was an illusion, not only to the deep shadows beneath the nearly unbroken canopy of the forest, but also to the crude murders which occurred in the area within a few decades of its settlement. While the land was purchased with the more suitable uplands, much of it was left idle and virtually untouched. The title to the land passed from family to family until several holdings were consolidated and a corporation, known as the Garland Dells Mineral Springs Association, was formed to exploit the natural mineral waters (Blatchley, 2). Within a decade of the turn of the century, the resort became the property of Joseph W. Frisz. A love of the land caused Frisz, the "pioneer conservationist," to reinvest much of his profit in the land, until by 1942 "The Shades Scenic Park" comprised more than 2,100 acres (Roll, 41).

When Joseph Frisz died in 1939, his corporation stock was divided among his children. With several stockholders, each possessing a

different opinion of operational procedure, the park became a liability. When the Shades was offered for sale, "Timber companies immediately evinced great interest in the magnificent trees, especially the top-grade white oak. . . . Thus, the Shades seemed doomed for destruction," (Indiana Department of Conservation, 31). A campaign to "Save the Shades" was initiated immediately and found the sympathetic support of the school children, fraternal organizations, and other citizens of Indiana and her neighboring states. The park was thus dedicated on July 18, 1948, as the "Shades State Park," the fifteenth such area set aside in Indiana.

Various widely known botanists have visited the Shades since the late 1800's. The only known data published regarding its plant life, however, are brief notes by Deam (12) and Friesner (27). Soon after its acquisition by the Indiana Department of Conservation, it was apparent that a botanical survey was necessary to determine the types of plants present in the park, and to determine what measures might be necessary for the preservation of the less common species. This survey was initiated under the auspices of the Division of Lands, Waters and State Parks, Indiana Department of Conservation, and the Botany Department of Butler University while the author served as resident naturalist.

SIZE AND LOCATION OF THE AREA

The Shades State Park occupies an area of 1,952 acres situated in Brown Township, Montgomery County; Howard Township, Parke County; and Jackson Township, Fountain County, Indiana. (T. 17 N., R. 6 W., Sections 2, 3, 4, 5, 9, 10, 11; T. 18 N., R. 6 W., Sections 33, 34). It is approximately 5 miles north of Waveland, 50 miles west-northwest of Indianapolis, and 125 miles south-southeast of Chicago.

GEOLOGY, PHYSIOGRAPHY AND SOIL FEATURES

The Shades State Park lies within the Tipton Till Plain described by Malott (37), an area which was subjected to glaciation by both the Illinoian and Wisconsin (Tazewell substage) glacial stages. The soil of the uplands, primarily Miami silt loam, is derived from glacial and loessial materials. It is known locally as "sugar-tree land" on account of the predominance of *Acer saccharum* (Jones and

Orahood, 33). The soil of the ridges and ravines has been variously derived from the bedrock, glacial debris, and organic remains.

Bedrock consists of intermixed strata of shales, limestones, and sandstones of the Mississippian and Pennsylvanian eras. "The Mansfield sandstone (Pennsylvanian), being more resistant than the strata above and below it, has weathered into . . . bold cliffs . . ." reaching an extreme exposure of two hundred feet above deeply entrenched Sugar Creek (Jones and Orahood, 32). The tributaries of the main stream have their origin in, or are fed by, springs flowing from points where an impervious shale layer is exposed. These streams, in their adjustment to the level of Sugar Creek, have cut ravines of various width and depth. Where the springs must flow over a broad surface for any distance, beds of travertine, or tufa rock, often are formed. The extreme elevation on the park property is 771 feet above mean sea level, while the minimum elevation is slightly less than 550 feet.

FLORA OF THE PARK

During the summers of 1950 and 1951, frequent excursions were made into all sections of the Park. Prudent collections were made of each species found in order not to disturb the natural conditions. In the course of the field work, 329 new county records, including 2 species, 6 varieties, and 10 forms new to the State, were discovered. Many of these have been published, and the remainder will be published, in the Proceedings of the Indiana Academy of Science as a part of the Indiana Plant Distribution Records (23, 24).

Specimens of plants reported as State or county records were deposited in the herbarium of Butler University, while many of the other specimens are now in the herbarium of Rutgers University, the State University of New Jersey, and the private herbarium of Mr. Julius Cohen, Newark, N. J.

The nomenclature followed is that employed by Fernald in Gray's Manual of Botany, Eighth Edition (25), the most recent manual treating this region. The present study of the vascular flora of the Park comprises 627 taxonomic entities (531 species, 56 varieties, 39 forms, and 1 hybrid) including representatives of 326 genera and

98 families (table I[1]). In addition, 23 species are known to be persisting after cultivation but are not reproducing.

The major divisions of vascular plants, Pteridophyta and Spermatophyta, are represented by 30 and 597 entities, respectively. The subdivision Gymnospermae has 4 representatives, while the class Monocotyledoneae has 141, and the class Dicotyledoneae has 452 representatives. In the latter class, 54 entities are of arborescent habit and 39 are shrubs or woody climbers.

The family Compositae has the greatest number of local representatives, 86 entities. Gramineae, with 71 representatives, ranks second. Other families, in the order of the abundance of their representatives, are: Leguminosae, 33; Cyperaceae, 29; Polypodiaceae, 27; Labiatae, 17; and Scrophulariaceae, 17.

DISTRIBUTION AND STATUS IN INDIANA

The range of 613 species known to occur in the Shades was determined from the maps presented by Deam (12) and from the subsequently published records of the State Flora Committee of the Indiana Academy of Science (13-24). Forty-five per cent (276) of the species of known distribution are found to be common to all six Indiana floral areas. As a result of the location of the Park, all the species which appear in its flora are recorded as occurring in the Tipton Till Plain; 93% occur in the Illinois Drift plain, 92% in the Unglaciated area, 88% in the Lakes area, 64% in the Lower Wabash Valley, and 61% in the Prairie area.

The status of plants, whether native or introduced, was determined by reference to Deam (12) and Fernald (15). Five hundred and twenty species (83%) are considered native to Indiana; the remaining 107 species have been variously introduced.

DISTRIBUTION IN THE UNITED STATES

The national distribution of 604 species was ascertained from the accounts given in Gray's Manual of Botany, Eighth Edition (Fernald,

[1] Table I of the original MS is on file in the Botanical Library of Butler University and is available upon loan. A mimeographed check list of the 627 taxonomic entities is available from the Butler University Botanical Library upon request.

25), the Flora of Indiana (Deam, 12), several other state and regional floras, and the periodical literature. Areal distribution was plotted and has been described by employing the cardinal points and their primary intermediates.

Sixty-eight per cent (413) of the species which occur in the Shades State Park occur in areas in each of the eight compass directions from the State and are considered, therefore, to be intraneous (Cowles, 10). One hundred and ninety-one species are extraneous, i.e., not recorded from one or more of the eight directions. Well over half of the extraneous species (118) are recorded as occurring in all but one of the eight directions.

Forty species reach their northern limit, 24 reach the southern limit, 7 reach the eastern limit, and 3 reach the western limit of their range in Indiana. Limits of distribution in the intermediate directions can be ascertained with less certainty because of the limited detail of the data available. It may be concluded, however, that the affinity of the flora of the Shades is least with the southwestern and northwestern regions.

DISCUSSIONS

The vascular flora of the Shades State Park includes a larger number and variety of species than had been anticipated at the inauguration of the study. While the survey was as intensive and extensive as the prevailing circumstances permitted, several portions of the Park remain to be investigated. There is little doubt that other species, especially members of the Cyperaceae, do occur within the boundaries of the Shades.

Extraneous species have been estimated to comprise from 40 to 45% of the total flora of Indiana (Deam, 11; Friesner, 27), 40% of the ferns and fern allies (Clevenger, 6), 62% of the grasses (Cook, 7), 56% of the shrubs (Trefz, 47), and 41% of the trees (Lindsey, 36). The extraneous element in the flora of the Shades is a consistently smaller portion of each group. The difference between the figures presented for the Park and those cited for the State ranges from 8 to 40%. Extraneous species comprise 32% of the total number of species, 23% of the ferns and fern allies, 22% of the grasses, 44% of the shrubs, and 33% of the trees found in the Shades.

These variations may be attributed to several factors: 1) Over 60% of the extraneous species in the flora of the State fail to reach the Tipton Till Plain, the region in which the Shades State Park is situated (Friesner, 27). 2) The majority of the previous estimates was made from 15 to 30 years ago. Range extensions of a number of species have been published since that time. The two most comprehensive compilations of specific ranges to appear for some time have been published within the past two years: Gray's Manual of Botany, Eighth Edition (25), and the Manual of Grasses of the United States, Second Edition (Hitchcock, 29). 3) The Shades has no natural pond or lake in which hydrophytic species, several of which are extraneous, could establish. The Park's two artificial lakes, created by raising small dams, apparently are either unfavorable habitats for those species, due, perhaps, to significant fluctuations in their water levels which may occur several times a year, or have not been in existence long enough to allow for the migration and ecesis of a sufficient number of hydrophytes to initiate hydrach succession. (4) The known flora of the Shades is composed of only about one-fourth of the total number of entities known to occur in the State (Deam, 12). As other species are discovered, the percentage of extraneous species in some groups may be altered significantly.

Nearly one-half of the species found in the Shades are present in every botanical area in Indiana. This number will no doubt be increased as our knowledge of the flora of the State becomes more complete. It is notable that the flora of the Shades has more species in common with the Illinoian Drift Area and the Unglaciated Area than the other floral regions (excepting the Tipton Till Plain). This situation might be expected, since the topography and geology of those areas resembles that of the Park to a degree. Outcrops of Mansfield sandstone occur in both the Areas. Roll (41) observed that the "deep ravines and picturesque Sugar Creek . . . (are) reminiscent of . . . the cliffs of the Muscatatuck River . . ." in the Unglaciated Area.

The fact that one-sixth of the flora of a tract set aside as "a part of original Indiana" (Cougill, 8) is made up of species which are not native to the State, and in a majority of the cases are not native to North America, bears striking evidence to the rapidity and thoroughness with which such plants are invading our land. The first intro-

duced plant probably entered the area occupied by the Park less than 120 years ago. The proportion of non-native species in the flora of the Shades is slightly greater than the 14% cited by Deam (12) for the State. The rapidity of introduction may be somewhat excelled in an area visited by thousands of persons from all parts of the United States each year. Any peculiarity due to such a condition is compensated by the distance of the Park from heavily traveled highways. The major portion of the introduced species is found in disturbed areas which have been created either by agricultural activities or by the construction of roads, clearings, or other facilities.

The new county records discovered during the course of this investigation may be grouped into three categories: those which merely "fill in" the previously known distribution of a species in the State; those which represent a minor western, southern, or northern extension of the known range of a species in central Indiana; and those which represent significant extension of the range of a species within the State. The first of these groups is by far the largest and requiries little discussion. It is exemplified by such species as *Daucus carota, Phryma leptostachya, Plantago rugelii,* and *Aster pilosus.* The second category is nearly as large as the first. The records of *Dennstaedtia punctilobula, Tsuga canadensis,* and *Bidens comosa* from Fountain County; *Pinus strobus, Atriplex patula,* and *Ranunculus sceleratus* from Park County; and *Botrychium dissectum, Oxalis europaea* var. *bushii* f. *sub-glabrata.* and *Eupatorium coelestinum* from Montgomery County are to be considered here. The third section is the smallest and perhaps the most interesting. In it may be classed the report of *Crotallaria sagitallis,* formerly recorded only from the extreme southern portion of Indiana. Here, too, may be classified the records of *Lindernia anagallidea* and *Gratiola virginica.* These species had not been reported previously from the Tipton Till Plain.

The apple of Peru, *Nicandra physalodes,* previously reported from only 10 counties, is apparently becoming a frequent weed in cornfields in and about the Park. Its close resemblance to *Datura stramanium* has caused it to be overlooked by the landowners and possibly by other botanists.

The entities added to the state floral catalog are primarily varieties and forms which have only recently come to the attention of taxo-

nomists in the State. Two species added, however, deserve particular mention:

Lespedeza cuneata (Dumont) G. Don, a native of eastern Asia, was discovered almost simultaneously in Montgomery and Parke Counties as a part of this study, and in Crawford County. It has apparently been introduced as a soil improving legume, but in neither instance had the site been seeded to the species. Its source is not known to the local residents.

Houstonia minima Beck, a species native from western Illinois to Iowa and Kansas and southward to Arkansas and Texas, grows in an undeveloped section of the Park in an intensively pastured field now dominated by poverty-grass, *Danthonia spicata*. This new eastern station may possibly herald a natural migration of the species. If this species is migrating eastward, it should have been intercepted previously in sites much nearer its native range. Apparently, no observation of this occurrence has been made. It may be more plausible to suppose, therefore, that the species has been introduced by humans or other animals. The inconspicuous habit of the plant and the situation in which it occurs, well removed from the recreational areas and dwellings, eliminates the possibility that it was formerly cultivated. The chance that it has been introduced in stock rations is very slight, since the feed has been produced on the farm for a number of years. The size of the plant is also a factor weighing against the latter possibility since most harvesting machinery would not intercept a plant so low. In addition, its fruiting period is early, not occurring at the time of harvest. It is highly improbable that wild or domesticated animals could retain the seeds in their digestive systems long enough to allow them to be transported to the farm from the area in which the species is native. Seeds may have been introduced in dung-gloves on the hoofs of newly acquired farm animals purchased in Illinois.

The compilation of a catalog of the higher plants of the Shades State Park and the attempt to relate the flora to that of the State and the Nation is not intended as an end in itself. This work, it is hoped, will serve as the foundation for a thorough study of the vegetation of the Park. As Tansley and Chipp (46) have postulated, "Floristic study must necessarily precede and condition vegetational study. . . .

The one passes naturally into the other, and we cannot possibly obtain a complete knowledge of any plant covering without using both.

SUMMARY

1. The vascular plants of the Shades State Park, an area of 1,952 acres in west-central Indiana, were the subjects of a taxonomic investigation during the summers of 1950 and 1951. The vascular flora of the park was found to consist of 531 species, 56 varieties, 39 forms, and 1 hybrid—a total of 627 taxonomic entities. In addition, 23 species have been found persisting after cultivation.

2. Forty-five per cent of the entities which occur in the Park are found common to all six Indiana floral areas. With the exception of the Tipton Till Plain, in which the Shades is located, the Illinoian Drift region has the greatest representation in the park flora. The Prairie Area has the smallest representation.

3. Seventeen per cent of the species found in the Park are considered to be alien to Indiana.

4. Extraneous species, those not found in every direction from Indiana, comprise 32% of the flora of the Shades.

5 Forty species found in the Park reach the northern limit, 24 reach the southern limit, 7 reach the eastern limit, and 3 reach the western limit of their geographical range in Indiana.

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